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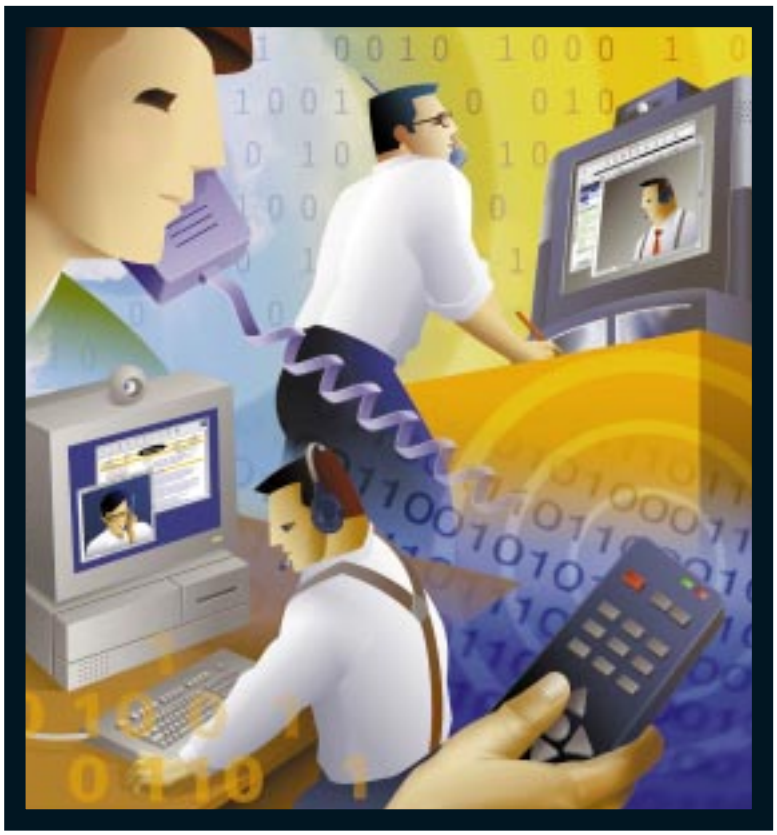

The easy guide to Data and Voice Networking

A guide to Convergence for growing businesses

Cisco Systems

Empowering the Internet Generation℠

The easy guide to Data and Voice Networking

A guide to Convergence for growing businesses

Here's a strong candidate for the most important word for the 21st Century. The word is *Convergence*. It's important because it will bring about one of the most subtle, yet profound changes in our modern way of life. Almost since its invention, the telephone has been a standard piece of equipment. We are used to seeing one on every desk in a company and at least one in every home. Now, the computer is achieving the same status. It is becoming a necessity, not a luxury. Convergence means the coming together of computer systems and telephone systems. Why is this so important? Because, like so many little things, it signifies something far greater. It means a change in the way that people communicate with each other.

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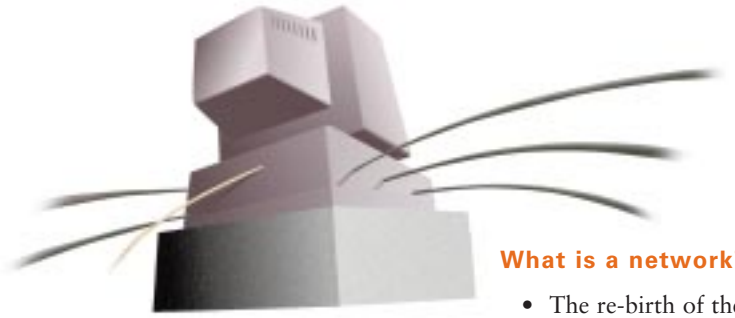
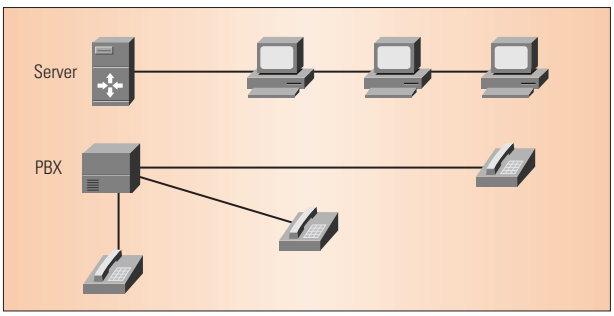


What is a network?

The first thing to do is to break a thinking habit. These days, when we use the word network we tend to think automatically that it means computers. Yet before computer networking, a network meant any collection of people or machines that were connected in such a way that some or all of the participants could communicate with each other. In this guide, when we talk about converging networks we are not talking only about computers. We are talking about computer networks and telephone networks. This kind of convergence is already taking place, with more and more companies of every size using their computer networks to send and receive faxes. Now the telephone, a device that we have taken for granted for so long, is about to be virtually reinvented. Computer Telephony Integration (CTI), Voice over IP (VoIP) and other new IP telephony solutions are driving the need for these changes.

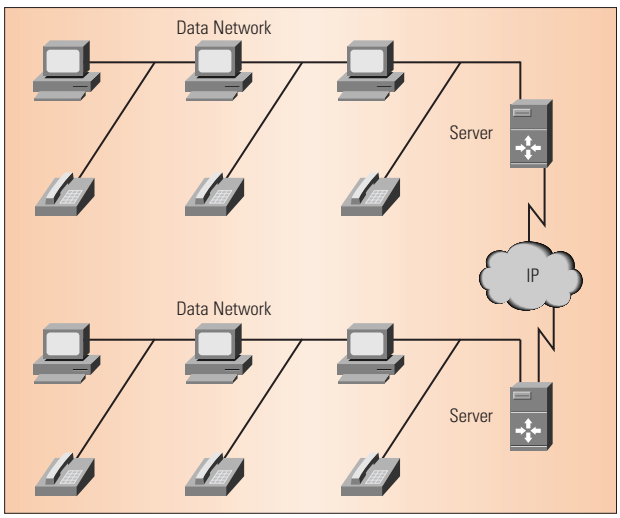
The Current Solution: *two networks*

Most organisations still have two communications networks: their telephone system and their computer system.

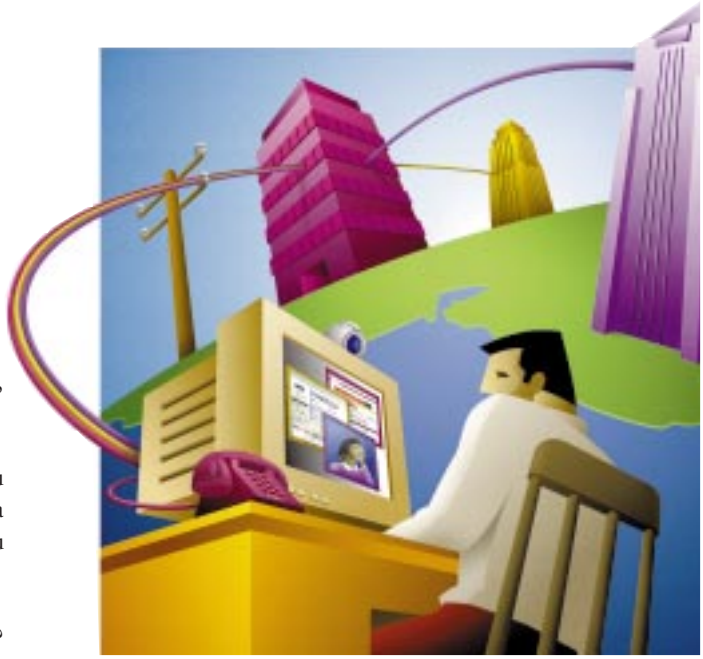


The Way Forward: *Voice over IP*

Voice over IP enables voice and data transmission to share the same network without compromising the quality of the voice call. New "Quality of Service" (QoS) technology means that companies large and small can achieve major reductions in their telephone costs.



The ways we communicate



If you have a problem, you can talk it through with someone. It helps to get an objective opinion and to clarify your thoughts. Sometimes, however, it is also a way of avoiding the real issue. Talking around the problem feels as though you are doing something about it, when really you are not.

Another way to deal with it is to write it down, even if you simply make a list of the alternative solutions. This is a much tougher option; the written word will not allow you to deceive yourself.

What has this got to do with computers and telephones? The point is, it highlights the radical differences in the ways we communicate with each other - and even with ourselves.

There are still more differences, too. Think about the difference between talking to someone on the phone and talking to them in person. When we can see each other, we communicate visually as well as verbally, with our eyes, our hands, the expression on our faces and who knows what other subtle ways.

Clearly, human communication has always been an "integrated" and "multi-medium" process. Now the technology we use to communicate is catching up. Computers and telephones are converging to give us almost as many options for technological communication as we have for our instinctive, biological communication.

The cost factor

We take the telephone for granted. Just over 100 years ago, it would have been unthinkable to be able to communicate verbally with someone in the next village, let alone on the other side of the world.

Yet in the short time that telephones have been around, we have learnt to use them almost as instinctively as we communicate face-to-face. However, just as there is a difference between talking to someone and writing to them, there is a difference between a telephone conversation and speaking to each other in person. Nevertheless, we seem to switch easily into telephone mode whenever we need to make or answer a call. Such is the miracle of evolution.

As always, however, the problem for new technology is economics. The cost of making long-distance and international telephone calls has maintained an instinctive unwillingness to use the telephone too much.

In the USA, where local calls are free, people are far more free and easy in their use of the technology. On the other hand, the ability to make free phone calls perhaps only makes you more conscious of the cost when you have to pay for the call.

As a result, the way we use the telephone becomes a function of who we are talking to and, more particularly, where they are. We are more willing to chat informally on a local call than we are on a more expensive long-distance or international call.

On this basis, it is not difficult to create a scenario where the economics of the telephone serve to maintain barriers between regions and nations. It could be argued that we respond differently when we call long-distance than when we call locally.

But whether you look at it on this deep level of consciousness, or simply look at your telephone bills, the plain fact is that cost is still a critical barrier to communication by telephone.

The Net connection

At the heart of the voice communication revolution is the Internet. The technology that built it is revolutionising communication for businesses and individuals at a rapidly increasing rate. Quite apart from e-mail and e-commerce (see Cisco's *Easy Guide to Networking* and *Easy Guide to E-commerce*) you can now use your computer to chat to people on the other side of the world, paying only local telephone rates for the connection.

But *chatting* in Internet parlance means typing out your ideas and answers, so that they appear on the other person's screen. As we have shown, writing things down is not the same spontaneous, instinctive process as talking.

Internet technology is about to break down even that barrier to communication between people. Convergence and VoIP are driving a communications revolution.

What is VoIP?

VoIP stands for Voice over Internet Protocol. In fact, the concept is disarmingly simple. It means that instead of using a telephone network to make a telephone call, you can use a computer network.

Simple though this sounds, its positive implications are enormous. Firstly, if your business has a computer network and a telephone network, in future you will be able to converge them into one, achieving big savings in time and cost in the process.

Secondly, if you have Internet access, you can place all your calls through the network provided by your *Internet Service Provider* (ISP). Just as you use your ISP's local *point-of-presence* (POP) to access the Internet at local call rates, with VoIP you can use the same POP for telephone calls. Those same local rates apply even if you are making a conference call, or taking part in a video conference.

Quality of Service

Telephone conversations are carried out on what are known as *fixed bandwidth connections*. This usually gives a connection that allows both parties to chat freely, almost as though they were face-to-face. This characteristic is termed *call quality*. However, if you have ever placed an international call, you will know that sometimes a delay can occur between what you say and what the other person hears. You will also know how disconcerting even that tiny delay can be.

For the teams developing VoIP, the challenge was still greater. The nature of the network technology with which they had to work meant that telephone calls placed on those networks could not guarantee fixed delays and performed more like ship-to-shore radio than conventional telephones. In other words, the calling parties had to take it in turns to speak, frequently resorting to saying "over" to tell the other person when they had finished what they had to say.

In simple terms, the achievement of VoIP is to overcome these problems. This is achieved by implementing *Quality of Service (QoS)* technologies. The breakthrough has been achieved by the use of standards based *Internet Protocol* networking.

Bandwidth and packets

To understand VoIP, we first need a crash course in networking technology. For a closer look at computer networking generally, you need Cisco's *Easy Guide to Networking*. Here, we are going to take a brief look at how networks actually work.

When you create a document on your computer you actually create a large bundle of computer code. If you then want to send that document down a network cable and a telephone line to another computer, it almost literally takes up a large chunk of space on the connection.

Engineers developed packet switching technology to simplify the ways in which large files were sent. In essence, these large data files are broken into *pieces* or *packets* that are sent in streams across the net and each individually addressed to the receiving computer. The receiving computer then reconstitutes this stream of packets into the original document!

It's like trying to force a large stone into a pipe that is only just big enough. Indeed, the comparison works well, because the way the technology solves the problem is to break the file into a stream of code, almost as if the stone had been ground in to smaller pieces. The computer at the other end rebuilds the file, in effect reconstituting the stone.

The limiting factor in the time taken to send a file across a data network is *bandwidth*. This is the term used by network engineers to describe the capacity of a cable to carry data. The larger the document, the more bandwidth required to carry it. If you then consider a large public data network in constant use you quickly build a picture of a network of cables crammed and congested with data. However, this congestion is not good for VoIP as it causes delay and leads to the *ship to shore* type of communication described earlier.

The solution is ingenious. Instead of each document taking its turn to be transmitted, the technology which breaks all the code into *packets* that can be carried together in sequence also assigns a priority level to each one. High for Voice packets, standard for data. All now follow each other in streams, branching off when they reach the link that will take them to their destination. The receiving computer collects all the packets that make up the document and recreates it.

The remarkable part is the ability of the system to separate out the relevant parts of each file and rebuild them again at the other end. In this way, thousands, even millions, of computer files of all sizes and formats can be carried simultaneously on a network. With the ability to also send Voice within packets (albeit of a higher priority) we can now support Voice and data on the same QoS enabled network.

Frame Relay and ATM

As demand for network capacity has grown, new ways of getting more from existing bandwidth have been developed. Some providers of network services use *Frame Relay* technology, which is increasingly combined with *asynchronous transfer mode* (ATM) technology.

Both ATM and Frame Relay networks can also be used to support converged voice and data services. The issue is to ensure that network delay is tightly managed and controlled. Again, Quality of Service (QoS) provides the answer. Intelligent networking technologies can now distinguish between data and voice transmissions and allocate bandwidth accordingly. As a result, the network can always achieve maximum performance for both data and voice, even when it is carrying both types of signal simultaneously.

The IP solution

After many years in which many different types of networking protocol have been used, the explosion of the Internet has made Internet Protocol the most widely used of all. Through VoIP technology, IP is making convergence a viable option even for small businesses and private individuals.

The key difference is the role it plays in the connection between the caller and the main network, which may be operated by a telephone company or an Internet Service Provider (ISP). Internet technology allows virtually any kind of computer file to be exchanged between virtually any number of computers, as anyone who has ever surfed around the World Wide Web will know.

For the purposes of VoIP, a voice signal is converted into just another piece of computer data, so it can be managed just as easily. However, because of the requirement for QoS, it also means that voice packets must be electronically tagged and given priority over other data.

In fact, many large network operators (and those enterprises large enough to run their own dedicated international computer and telephone networks) may still use Frame Relay or ATM for their main cable connections, known as the *backbone* or *core* of the network.
But with a revolutionary and almost infinitely versatile technology to manage the congestion throughout the superhighway, the global communication breakthrough that is VoIP is finally becoming a reality. Above all, it is increasingly available to small or medium sized businesses and even to private individuals.

The international network

It is, perhaps, within major global organisations that the benefits of convergence are most apparent. At its simplest level, it means that the Hong Kong office can communicate with the Madrid office over a single network connection.

It also means that Hong Kong, Madrid, New York and London can share a conference call over that same single network. If they choose to use video-conferencing, the quality of the communication is improved still further.

The cost savings are obvious. Quite apart from the call charges, they add up to large reductions in air travel expenses, hotel accommodation costs and subsistence expenses, as well as in the sheer cost of the time lost while highly-paid executives travel to meet each other.

There is a positive contribution to be made as well. The logistics of communication across the enterprise are a root cause of the problems we so often curse as breakdowns in communication.

VoIP technology makes picking up the telephone - or, alternatively, dialling from your computer - a routine way of communicating internationally. With the physical and psychological barriers removed, information flows far more freely around the organisation.

Productivity increases, errors are reduced and cycle times speed up. Businesses large and small have already achieved faster time to market - and substantial competitive advantage - through the use of Internet technology. Adding voice to their arsenal of resources brings in another radical new dimension.

Education - the academic Intranet

Cost has always set the agenda in the education sector. Schools, colleges and universities fight a continuing battle to balance increasing demand with increasingly stretched resources.

The administrative structure of the education service also places a high demand on teachers and support staff. With education at the top of the political agenda, radical solutions are being deployed to help meet government objectives.

Technology is a central element of the new vision for education. To illustrate the point, we can consider a large suburban secondary school. It has a flourishing sixth form college and a growing adult education centre.

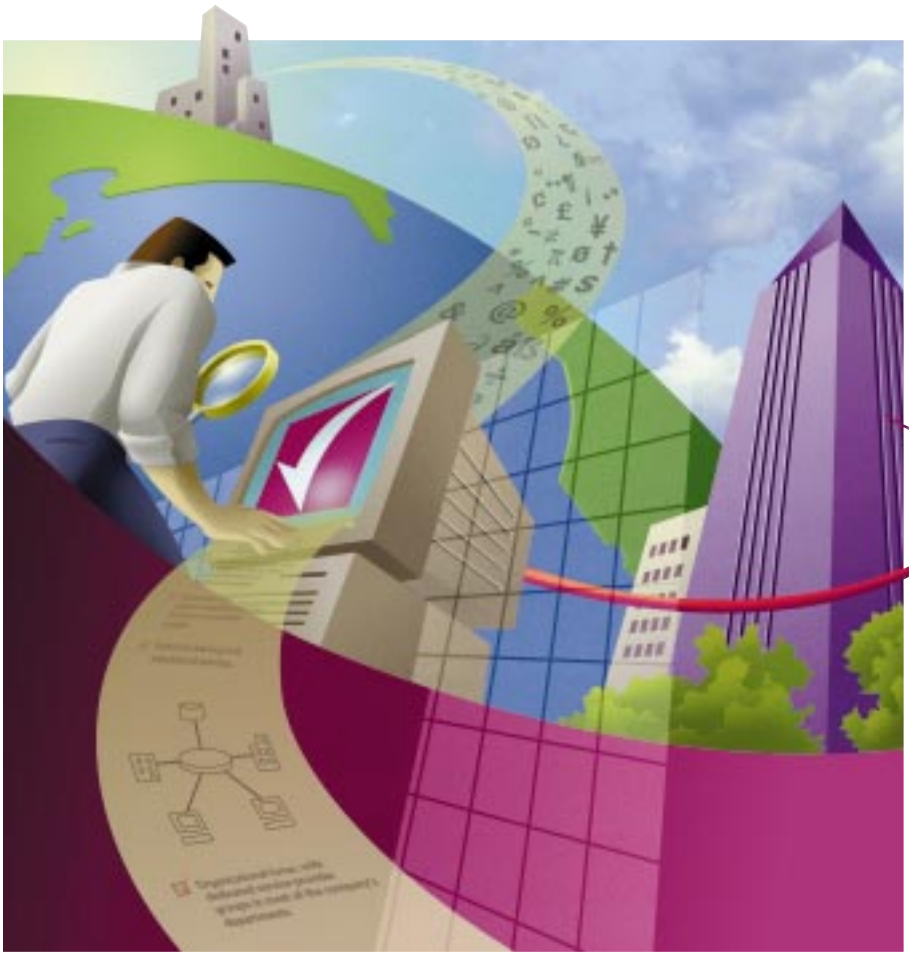
Convergence makes a significant contribution to the school in two broad areas. On the one hand, it has brought about a significant reduction in costs. On the other hand, it has enabled new ways of creating income.

The cost saving is achieved through an initiative by the Local Education Authority. All the schools and colleges in its area are connected through a Wide Area Network running an Intranet - a private, Internet-style network. At first, this was used primarily for the exchange of administrative data. However, by deploying VoIP, the LEA has enabled all schools to use the Web for telephone calls as well.

By far the majority of telephone charges incurred by our secondary school are for calls made to the LEA or associated organisations. Now those calls can be made free of charge via the Intranet.

The school has also begun to experiment with “distance-learning”. Sixth form students and mature students have been able to listen and contribute to lectures by dialling in through their PCs.

In addition, the school can now attract students from far beyond its normal catchment area. It can also offer a wider and more competitive range of studies, since demand for less mainstream subjects is no longer defined by geographical limitations.



Internal communications are also improved. Using conference calling technology, the chain's regional directors can hold monthly meetings of all their branch managers without the managers ever having to leave their stores.

Quite apart from the savings on travel and accommodation charges, the use of the telephone as a medium concentrates the minds of all those taking part, so that the meeting is finished more quickly and achieves more in the way of firm decisions.

There are more examples of this kind of electronic commerce in Cisco's *Easy Guide to E-commerce*.

The private user

Like e-mail and the World Wide Web, VoIP is an application that will drive the Internet into the homes of people who would not normally have considered buying a PC.

Families once separated by thousands of miles will be able to rekindle their relationships through telephone calls made over the Internet.

With the world shrinking in economic terms, the pressures to travel far from home, on business trips or in search of permanent employment, are stronger than they have ever been. The knowledge that being far away does not mean being out of touch opens up more opportunities for people to travel and reduces the stress for those who are a long way from home.

Retail - the virtual department store

By converging its computer networks and its telephone networks, a chain of shops can be turned into a vast virtual department store.

Like the schools and colleges, a large retail chain can use Internet technology to link its various branches. Unlike the education sector, however, a retailer may find it more cost-effective to create what is known as a *Virtual Private Network* (VPN).

Instead of dedicated lines to connect the branches, the retailer can create a secure network that each branch can access through the ISP. Although a charge is made for the connection, it is still only a local call.

It is an approach that can revolutionise customer service. If an item is out of stock, a glance at the network can show the sales person if it is available elsewhere. The customer no longer has to wait while a series of phone calls are made. Better still, if the logistics are set up correctly, the item could even be delivered later the same day.

Empowering convergence

For decades, the standard form of voice network management has been the PBX (private branch exchange), with its familiar switchboard console.

Today the PBX is becoming computer-based. The traditional console is gone and the modern telephonist or receptionist uses a PC. With VoIP IP phones will plug into the data network as will fax machines.

QoS - the Cisco Solution

As we have seen, the critical factor is *Quality of Service*. While computer networks are achieving peaks of efficiency and capacity, how can they provide the QoS required for voice transmission without having to be completely re-engineered?

As pioneers of Internet technology, Cisco has developed solutions that combine the best of the existing systems with revolutionary new ideas. The Cisco range incorporates a variety of solutions designed to provide data and voice integration for organisations of all sizes.

They are based on proven Cisco *routing* and *switching* technologies (see the *Easy Guide to Networking*). Cisco solutions include intelligent devices that can distinguish between voice and data signals and allocate bandwidth accordingly. So even if you are transmitting a huge data file - perhaps a presentation that includes moving images - you can still make a voice call over the same network. If you already have a Cisco IP network, upgrading to a full VoIP network may be as simple as adding dedicated Voice modules, or Cisco switching solutions that support QoS.

Talking to your PC

To make a VoIP call, you can choose from a wide variety of devices.

For those who feel most comfortable with traditional technology, there are Internet telephones that contain all the software and hardware you need. Currently, these are expensive machines, but, like video machines and PCs, costs will fall as demand increases.

By far the most commonly used way of making a VoIP call is through a PC. For this you need the following:

- *A PC with a modem that supports voice and data, or that is connected to a network that includes multiservice capabilities (such as a Cisco multiservice solution).*
- *A microphone and headset attached to the PC. A separate microphone and speakers can also be used, especially for conference calls.*
- *The relevant voice and data transmission software.*
- *A subscription to an Internet telephone service. As the demand for VoIP increases, many network service providers will provide voice and data services within a single subscription.*

To make a call, you establish an Internet connection and dial the number you are calling using the telephony software. Bandwidth is set aside within your local network for your call and transfers your voice data onto the backbone. This may actually be a Frame Relay or ATM connection, or even a combination of the two.

At the receiving end the recipient's local network can either carry the call back onto an IP network or take it direct to a conventional telephone. For true QoS, the long-term scenario will involve one IP network calling another, possibly with ATM or a similar technology running the backbone. This will be particularly true for business-to-business calls, where the internal network may well be entirely IP based.

Call centre systems

The convergence of computer and voice services is currently most apparent in the call centre environment.

Previously, call centres were used mainly by specialist service companies or telesales teams. They required big and expensive voice *switches*, known as *automated call distributors* (ACDs), to deal with the large volumes of incoming and outgoing calls. They had their own dedicated computer systems that could only be linked to the main enterprise network with complex software and hardware.

Today, an ACD can be a piece of software that runs on a server. Companies employing less than ten people can make cost-effective use of call centre technology, if they make extensive use of the telephone to sell or provide service.

Call centre systems can now link seamlessly to the main computer systems. When a customer calls, the telephone system interrogates the customer database and automatically presents details of the customer's account to the person taking the call. Probably one of the most interesting areas is exactly how the internet will change the support model especially with the growth of UK users and the ability to offer internet banking and other e-commerce based solutions.

Can you afford not to?

A vast range of other functions and services have been made possible by data and voice convergence. Ingenious as they are, their real significance is the opportunity they present to the companies using them.

Above all, the economics of the technology are fast making it a business imperative, rather than an interesting new idea. The equipment itself is growing less expensive and the huge cost savings mean that returns on investment are achieved very quickly.

For the business of the future, the choices will be much simpler. Instead of choosing a telephone system and a computer network, they will simply choose the integrated communications network that suits the way they work.

A new world of communication

It could be argued that somewhere between the laws of physics and the principles of economics lies the key to the human condition.

Psychologists talk about a "hierarchy of need", in which social companionship is said to be crucial; only food, shelter and protection from harm by others are believed to be more important to us. Technology is making this kind of social interaction possible on a much larger scale, because it makes it easier and cheaper.

That's why technology is far more than simply a fascinating array of ingenious devices. Something as simple as e-mail has already begun to remove international barriers to communication. It's so easy and cheap to send a message now that people are far more inclined both to make contact and to respond.

VoIP will add a remarkable new dimension. Speech is our most spontaneous and natural way of communicating - as far as we know! By removing economic and technical barriers to speech, VoIP makes it almost as easy for us to talk to someone in Sydney as it is to someone at the next desk.

For businesses, the benefits are clear. Massive cost savings, the ability to serve global markets, improved management and control; almost every area of business life is improved by better communication.

The benefits to individuals are equally far reaching. A company's ability to serve a global market means that consumers can shop across the world if they want to. However, in a world divided by cultural, linguistic and even philosophical differences, the ability to communicate across these barriers will perhaps prove to be the most valuable benefit of all.

Want to know more?

For help and information, contact Cisco Systems on 0800 328 7719 or call a Cisco Reseller. If you already have access to the Internet, you can find a choice of Cisco Resellers by visiting the Cisco Reseller locator site at www.cisco.com/public/partnerlocator.shtml. Alternatively, visit Cisco's homepage on the World Wide Web at http://www.cisco.com/uk

Glossary of Networking Terms

ACD
(Automated Call Distributor): An intelligent switch (see below) that manages telephone traffic through call centres.

ATM
(Asynchronous Transfer Mode): A high-speed networking technology that transmits various kinds of information (data, voice, video) and provides very granular QoS.

Backbone
The part of the network that carries the heaviest traffic; it connects LANs, either within a building or across a city or region.

Bandwidth
The maximum amount of data that a network cable can carry, measured in bits per second (bps).

Browser
A software package used to search information posted on the Web; Netscape and Microsoft Internet Explorer are the most popular browsers.

CTI
(Computer telephony integration): Software that enables computer networks and telephone networks to work together. Often used in call centres to provide agents with call specific data.

Convergence
The coming together of computer networks with telephone networks, enabling organisations to communicate over a single network.

Extranet
If you have an Intranet, you can turn part of it into an Extranet by allowing customers, suppliers and other key people secure access to the areas they need.

Frame Relay
Another high-speed networking protocol, often used for *backbone* connections.

Home page
The main page of a Website and the first screen that a visitor sees displayed when connecting to that site; usually has links to other pages, both within that site and to other sites.

Hub
The central connection point for a group of nodes; useful for centralised management, the ability to isolate nodes from disruption and extending the distance of LAN coverage.

Internet
The global network of computers, routers and cable connections that enables the world's computers to connect to each other.

Intranet
An internal network that uses the same technology as the Internet to connect its users, most notably employing browsers to provide a common interface. Intranets can stretch around the world.

IP
"Internet Protocol". The standard by which individual computers communicate on the Internet. All computers with Internet access are given a unique "address" consisting of four numbers separated by dots ("dotted-quad").

ISDN
Integrated Services Digital Network, a telecommunications standard for sending data signals, digitised voice and video over the existing Public Switched Telephone Network.

ISP
(Internet Service Provider): A company that provides access to the Internet. Increasingly, telephone network operators are also acting as ISPs.

Local Area Network (LAN)
Workstations and computers that are connected in a specific work area in the same general location.

Network Operating System (NOS)
Software that manages the resources of a network; typically provides file sharing, e-mail, print services, security measures, etc.

Node
Each of the individual computers or other devices on the network.

Packet
To enable many computer files (and voice transmissions) to be carried at once, the files are broken into smaller pieces of data known as packets.

PBX
(Private branch exchange): The switch at the heart of a telephone network within an organisation.

POP
(Point of presence): ISPs (see above) provide local points of connection to their networks. Wherever you are within the country or region served by the ISP, you can connect to the network paying only local call rates.

QoS
(Quality of Service). Technologies which provide the ability to offer a different level of service to different types of data traffic eg. voice.

Router
A device that connects multiple networks; and intelligently routes packets between them.

Server
A network node that provides services to client PCs, for example, file access, print spooling or remote application execution.

Switch
The devices that conducts traffic (in the form of packets, see above) around a network. The latest switches can distinguish between data and voice packets to ensure QoS for the voice communication.

URL
Uniform Resource Locator, the standard way to write the address of a specific site or piece of information on the Web; for example, http://www.cisco.com/uk

Virtual Private Network (VPN)
A WAN which functions as a LAN. Geographically remote locations can communicate over public networks such as the Internet while enjoying the privacy, speed and availability of a local connection.

Voice over IP (VoIP)
The facility to have a telephone conversation via an IP network. You can connect to your local point-of-presence and call someone on the other side of the world, paying only local rates for the call or alternatively pass inter-office voice traffic person-to-person call or fax-to-fax call across the data network.

Wide Area Network (WAN)
A geographically dispersed network that connects two or more locations typically involves dedicated high-speed data circuits.

World Wide Web
The vast pool of information and resources that is most widely used to communicate and trade via the Internet.

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